A new look at Pattani Malay Initial Geminates:

A statistical and machine learning approach

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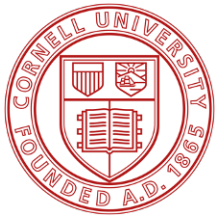
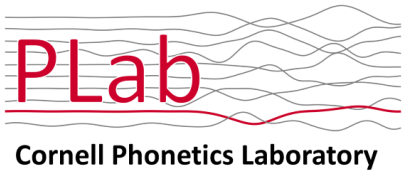
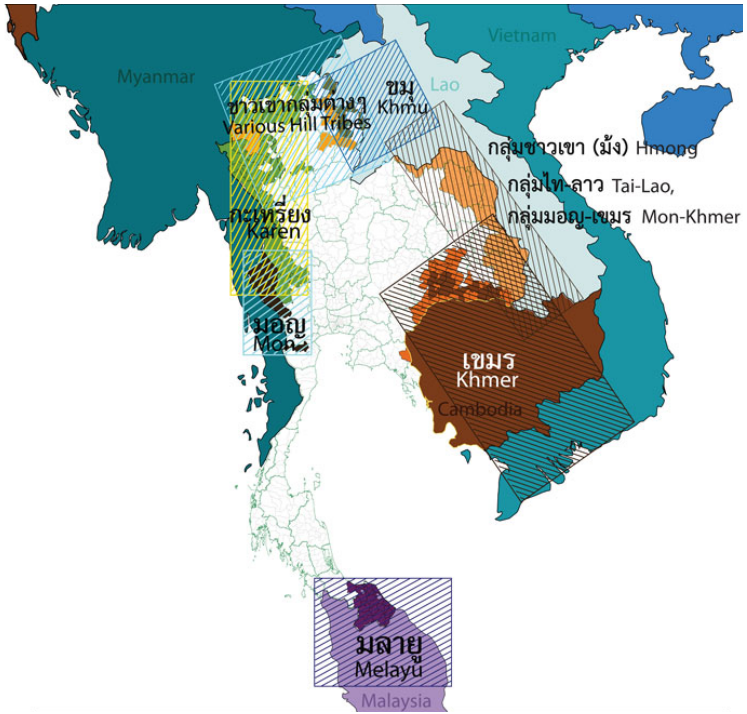




Pattani Malay

- Spoken in the 3 southernmost provinces of Thailand: Pattani, Yala, and Narathiwat
- 1,300,000+ speakers according to the latest census (National Statistical Office 2012a, 2012b 2012c)
- Closely related to Malay dialects of northeastern Peninsular Malaysia, i.e. Kelantan and Terengganu (Uthai 2011)



CDREL, Mahidol University
(https://langrevival.mahidol.ac.th/project/lang-map-border-thailand/)

IGs are contrastive for all consonants

Geminates	Singletons
/mmatɔ/ ‘jewelry’	/matɔ/ ‘eye’
/kkatoʔ/ ‘frog’	/katoʔ/ ‘hammer’
/ggaɟi/ ‘saw’	/gaɟi/ ‘wage’

PM lacks medial/final geminates, unique linguistic situation

Previous studies reported the following acoustic cues to IGs in PM

	Geminates	Singletons
Consonant duration	longer x 3	shorter
Vowel duration	longer ?	shorter ?
Vowel F0	higher	lower
Vowel Intensity	higher	lower

Abramson (2004) argued that F0 and intensity are becoming increasingly salient perceptually, which may lead to the emergence of a prosodic contrast.

This study

- Naturalistic data from a larger pool of speakers
- Statistical analyses reveal small differences in consonant duration
- LDA classification performs only slightly above chance
- IGs may be only marginally contrastive

Acoustics analyses

Data collection

- 14 speakers (6M; 8F) in age range 20-61 y.o. (μ = 33, σ = 16)
- Target words: 13 disyllabic minimal pairs x 6 repetitions
- Each target word embedded in two positions: medial & final
- Each sentence cued by a natural sounding corresponding Thai sentence

Eight acoustic measurements

	Initial segment	Initial syllable	First 10% of following vowel
Duration (ms)	raw	raw	
F0 (semitone)		μ	μ
Intensity (dB)		max	μ

Relative measurements:

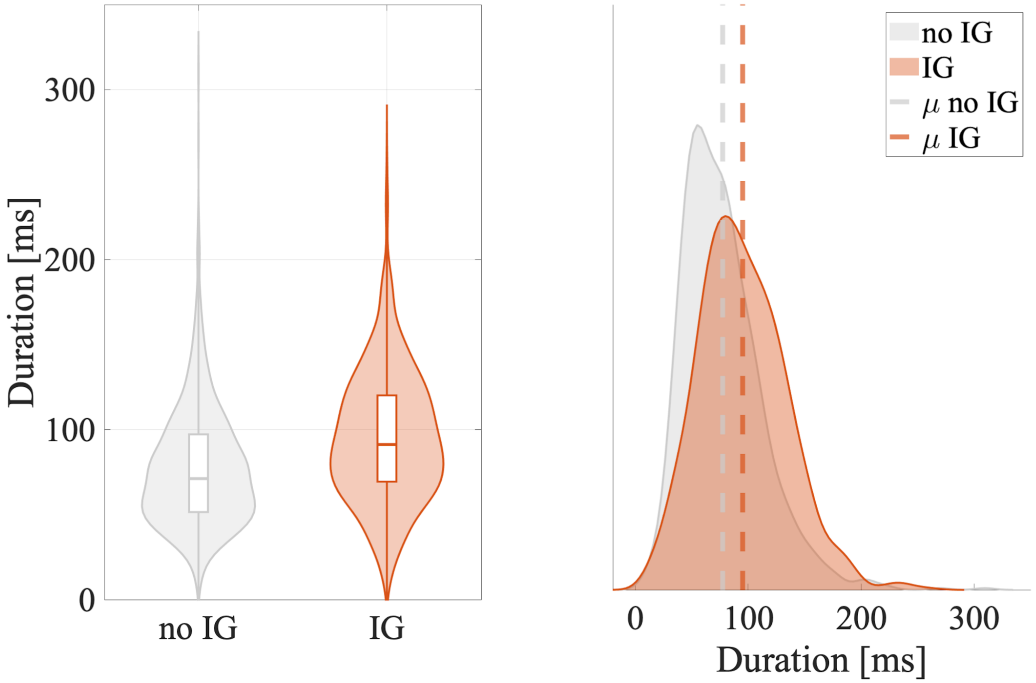
(1) μ F0 of initial syllable - μ F0 of final syllable

(2) μ RMS amplitude of initial syllable / μ RMS amplitude of final syllable

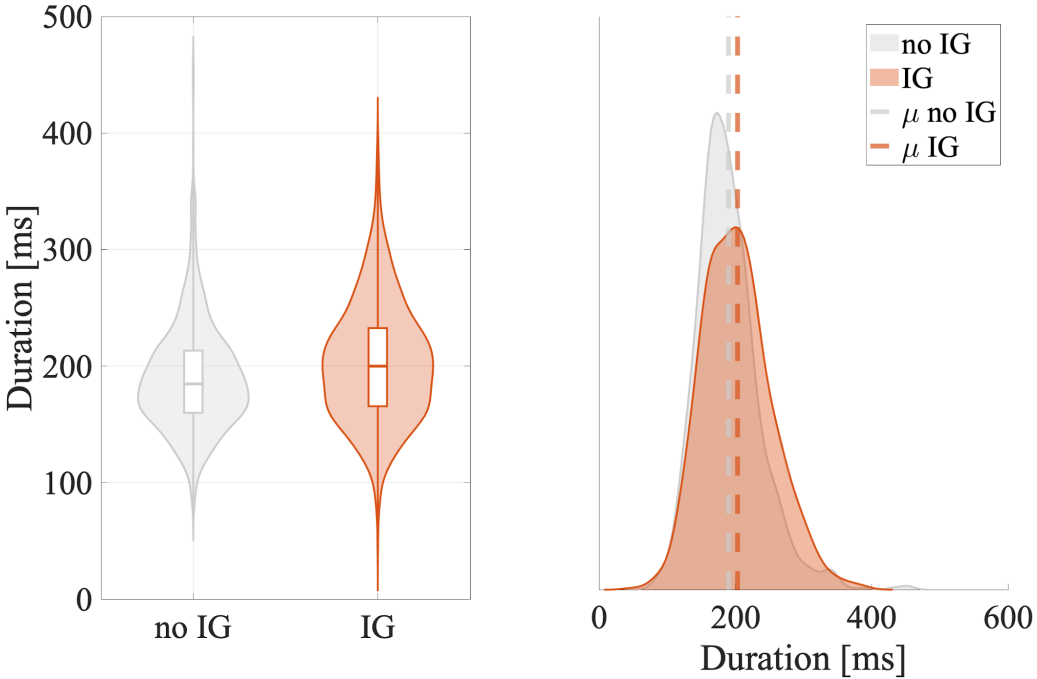
Statistical analyses

- Linear mixed effect regression
- Compare a model where the fixed effect was the presence/ absence of IGs to an intercept-only model
- Random effects: subject, word, position of word in a phrase (medial/final)

IGs are significantly longer than **singletons** (~17 ms)

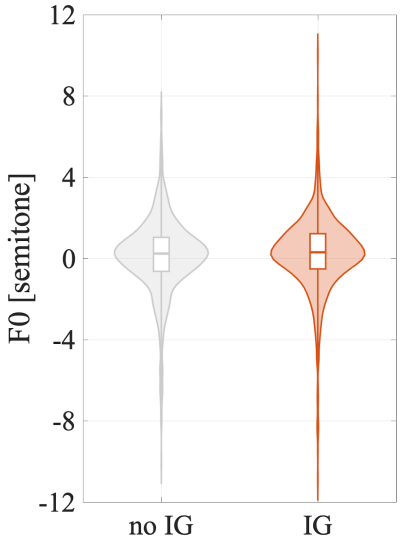


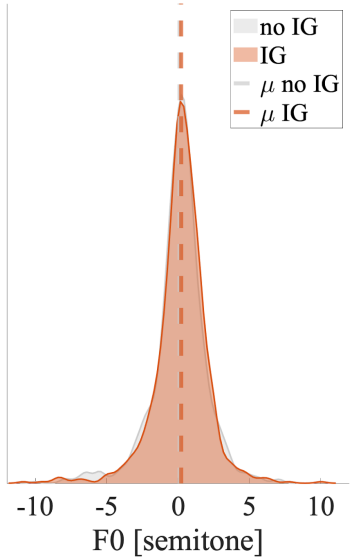
No difference in **syllable** duration

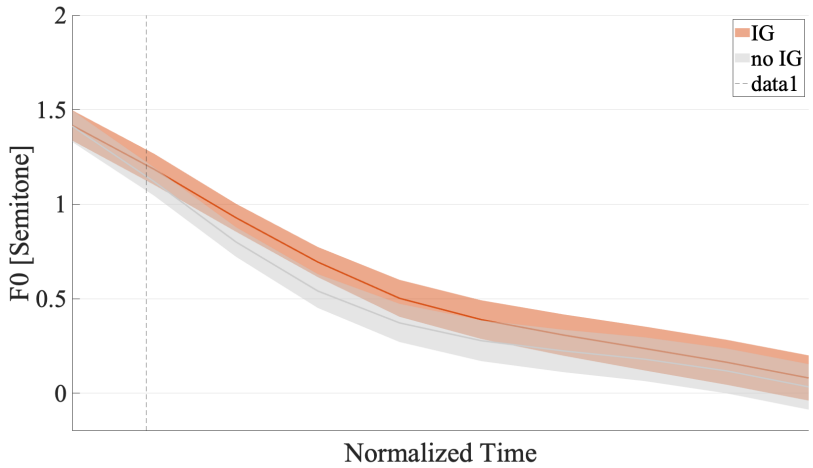


No difference in **F0** after IGs/singletons

both for the entire vowel or the first 10%

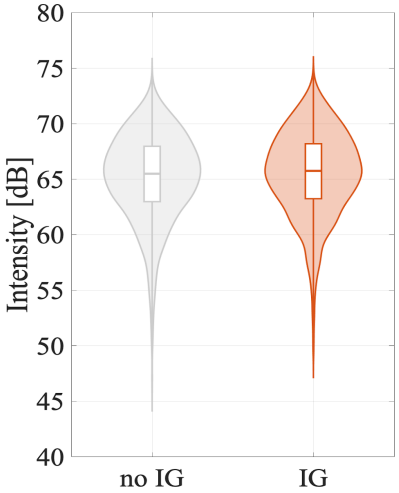


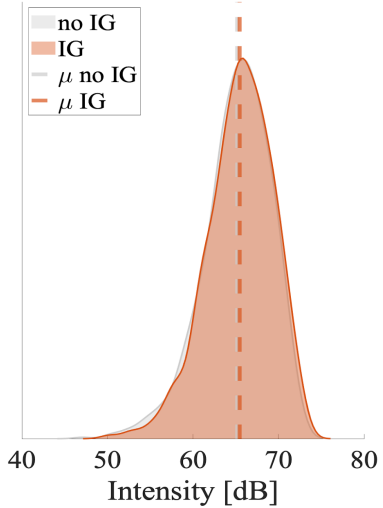


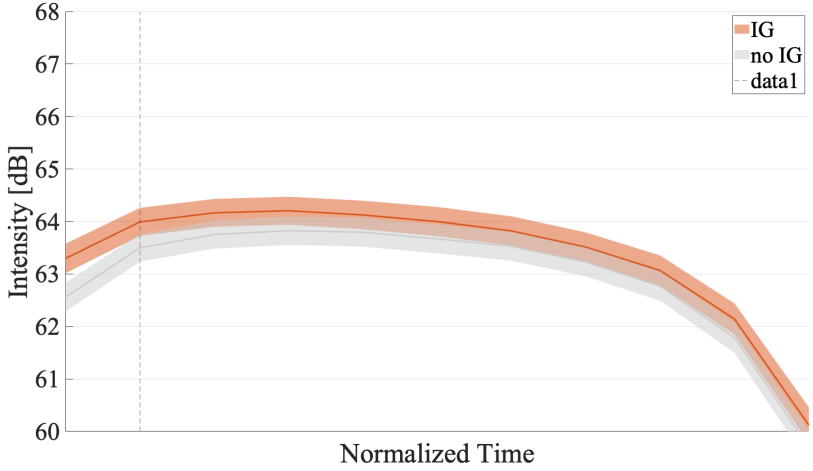


No difference in **intensity** after IGs/singletons

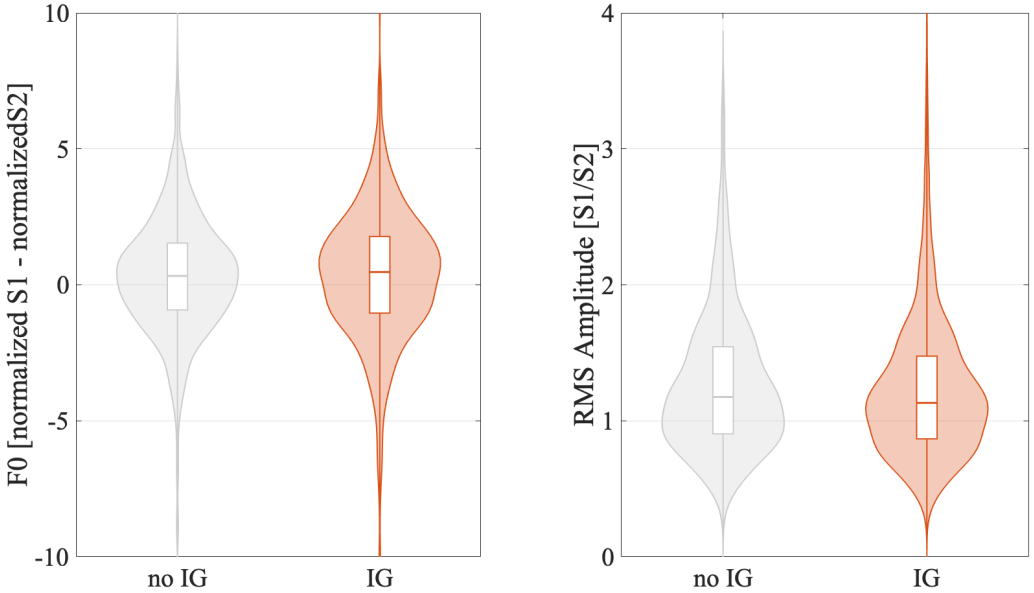
both for the entire vowel or the first 10%







No difference in **F0 Δ** or **RMS amplitude** *ratio*
of initial and final syllable



The only (small) difference is segment duration

	Initial segment	Initial syllable	First 10% of following vowel
Duration (ms)	✓ (17 ms)	✗	
F0 (semitone)		✗	✗
Intensity (dB)		✗	✗

Relative measurements:

- ✗ (1) μ F0 of initial syllable - μ F0 of final syllable
- ✗ (2) μ RMS amplitude of initial syllable / μ RMS amplitude of final syllable

Linear discriminant analysis (LDA)

LDA used to distinguish singleton vs geminates

- Very successful for medial geminates, e.g. in Japanese (~95%)

(Idemaru & Guion-Anderson 2010, Amano et al. 2019)

- Less successful, but still good for IGs, e.g. in Salentino (~80%)

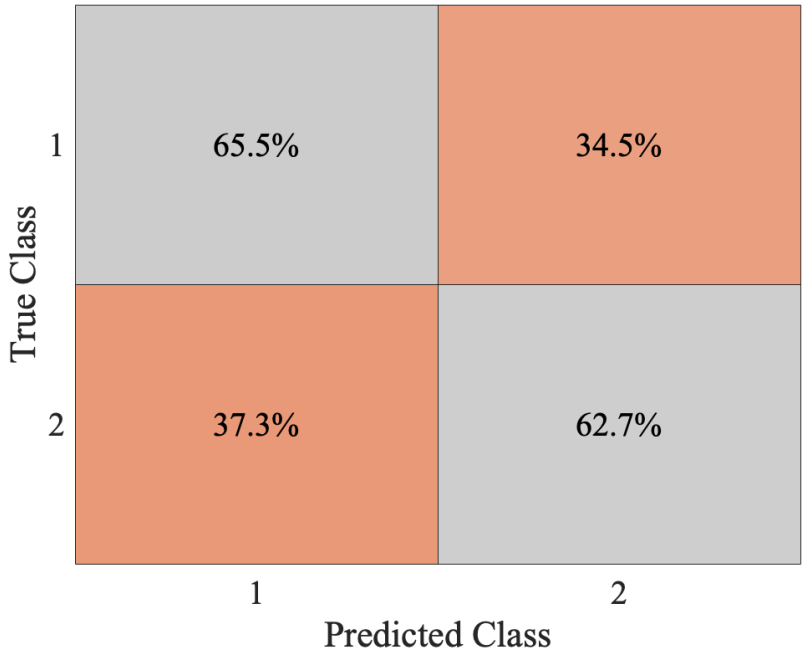
(Burroni & Maspong to appear)

Methodology and feature selection

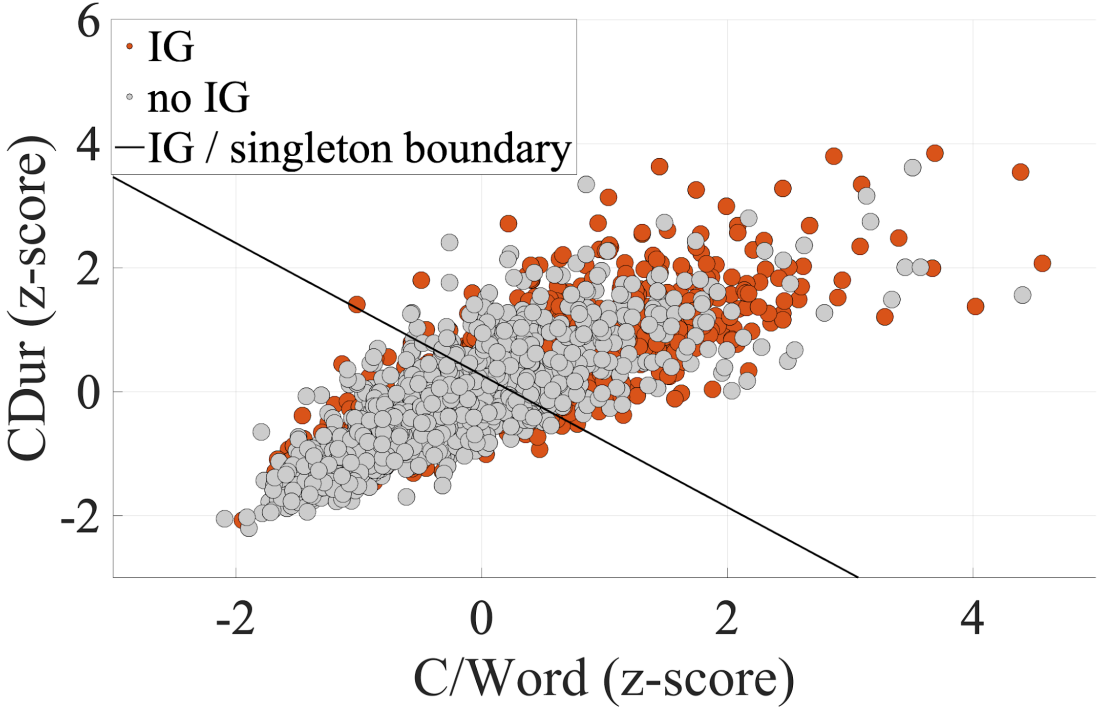
- Data partition: 80% (training) 20% (test)
- 10,000 LDAs (μ and covariance matrices)
- Report μ accuracy and σ of these models in predicting classes
- Features: CDur* and CDur/WordDur* , σDur, σMeanF0, σMaxInt
- All features z-scored

Classification above chance, but poor (~62%)

Model Structure	Mean Accuracy	Standard Deviation
CDur + CDur/WordDur + σ_iDur + σ_iMaxInt + σ_iMeanF0	58.84%	2.18%
CDur + CDur/WordDur + σ_iDur + σ_iMeanF0	58.20%	2.07%
CDur + CDur/WordDur + σ_iDur + σ_iMaxInt	58.88%	2.20%
CDur + CDur/WordDur + σ_iDur	58.19%	2.10%
CDur + CDur/WordDur	**61.40%**	2.06%
CDur/WordDur	59.84%	2.14%
CDur	**62.36%**	2.11%



Why is classification of Pattani IGs so low?



Interim Summary

- Classification above chance suggests the existence of a singleton/IG contrast …
- But low classification accuracy, large overlap, and limited statistical differences show that the contrast is subtle (*contra* previous descriptions)
- What is happening to the singleton/IG contrast in Pattani Malay?

Discussion

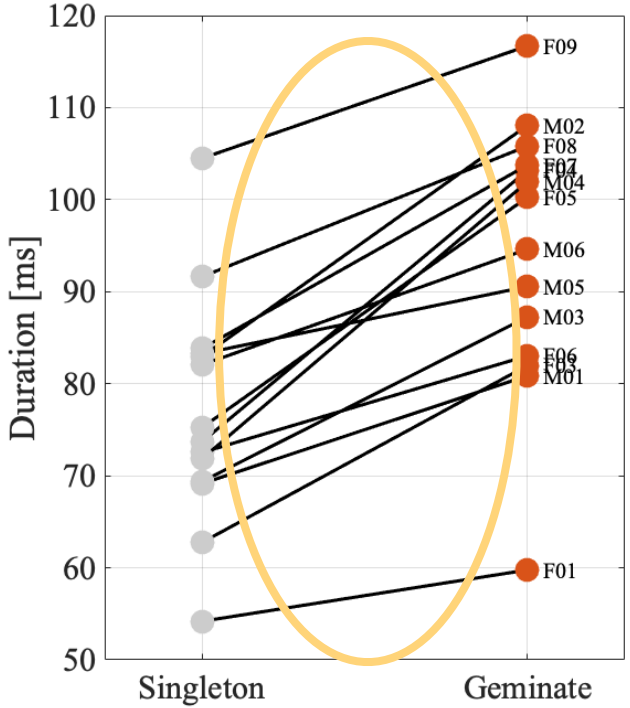
3 Hypotheses

1) Contrast is being neutralized in naturalistic speech
2) Contrast is being neutralized for some speakers
3) Contrast is being neutralized for some minimal pairs

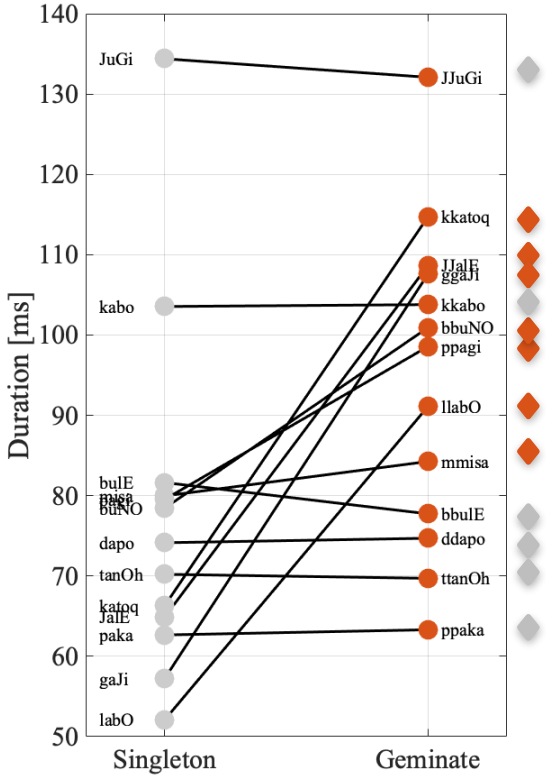
(1) Contrast is neutralized in naturalistic speech (?)

- Previous work on Pattani Malay IGs limited to words in isolation or in carrier sentence == hyper articulated speech
- Perhaps contrast not as robust in naturalistic speech
- We cannot assess this because we do not have lab and naturalistic speech from the same speakers
- Follow-up study planned

(2) Contrast neutralized for some speakers (✗)



(3) Contrast neutralized for some minimal pairs (✓)

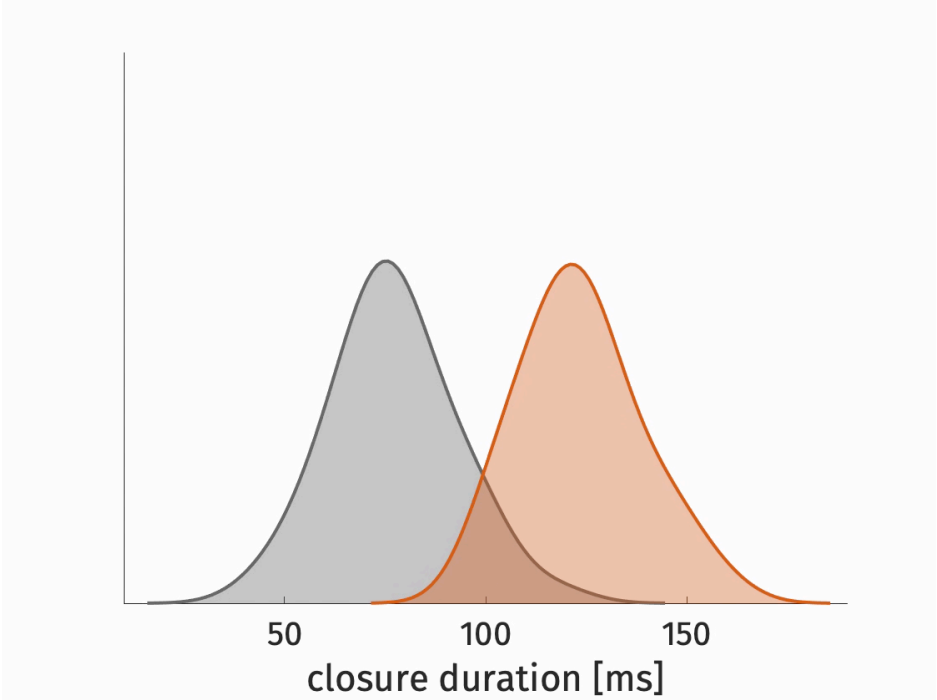


Why contrast neutralization for some lexical items?

- Evolutionary Phonology (EP) holds that IGs tend to degeminate
- IGs survive only when they “compete” lexically with singletons,
- When they are the unique cue to word meaning e.g., when they mark a different form of the paradigm
- This is modeled with a random walk without and with exemplar trading

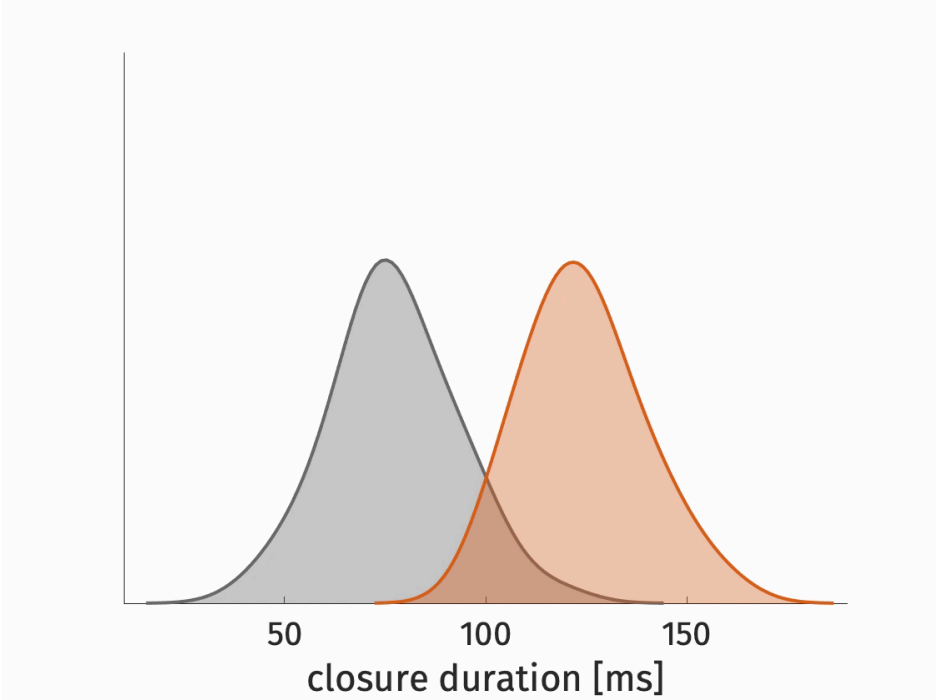
(Blevins & Wedel 2009)

When IGs can be disambiguated from context…



no exemplar trading, merger is possible (random walk)

When IGs ***cannot*** be disambiguated from context…



Exemplar trading, merger is blocked (random walk with a wall)

Does this work for Pattani Malay?

- Some forms **disambiguated** by (morphosyntactic) context **do merge**…
  - e.g., [dapo] ‘kitchen’ and [ddapo] ‘at the kitchen’
- … but forms **not disambiguated** by context **also merge**
  - e.g., [kabo] ‘Java kapok’ and [kkabo] ‘beetle’
- Lexical competition alone not enough to predict the fate of IGs

(Burroni & Maspong to appear)

What other factors may be responsible for loss of contrast?

- IGs no longer used for morphological derivation (e.g. causative, passive) (Uthai 1993)
- Perhaps IGs have a reduced “functional load” (FL) $\frac{H(L) - H(L_{xy})}{H(L)}$
- FL known to correlate with **C/CC duration** and **resistance to merger**
- If Pattani Malay corpora were available we could estimate FL

Status of the singleton vs IG contrast in Pattani Malay?

- Contrast currently observed for some minimal pairs only
- **Marginal or quasi-phonemic**?
- Strikingly different from previous reports, but …
- …in line with reports that marginal contrasts display large overlaps in naturalistic speech (Cohn & Renwick 2019)

Conclusion

5 takeaways

1) Difference between IGs and singletons is C-duration, LDA classification is not very accurate (~62%)
2) Large distributional overlap, *contra* previous reports, which, however, used different data collection strategies
3) All speakers realized the contrast, but only for some minimal pairs
4) Counterexample to the EP claim that contrast is maintained for minimal pairs that compete morphosyntactically and lexically
5) Information theoretic measurement, like FL, may help us better understand why and how the IG/singleton contrast is changing

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